GEOLOGY 350 STUDY GUIDE FOR MIDTERM

Midterm will cover material from beginning of course up through landslides, including ideas of stress and strength. I am interested in your grasp of *general concepts and fundamental principles, and your ability to apply them to specific situations*, i.e., your ability to use them to solve problems for which there is no cut-and-dried answer. I am especially interested in developing your reasoning and your ability to express your thoughts clearly and concisely, without B.S. and excess verbiage. Thus my questions will usually require some sort of reasoning from basic principles rather than asking for regurgitation of minor facts from the text or lecture. In your answers, the *reasons* you give for answers will be as important (or more important) than the answer itself.

I have indicated below the sorts of ideas I'd like you to be thinking about while studying. I've also included some sample questions, indicated by an * in front.

SYSTEMS, PHILOSOPHY, SCHEMES OF LANDSCAPE EVOLUTION

*1. What are geomorphic thresholds? Think of some examples. Over what sort of time scale (order of magnitude, in years) would each threshold be most important? (i.e., to cross the threshold are we talking about changes taking minutes, hours, days, years, decades, centuries, millennia, or millions of years?)

2. Think about how driving forces (climate, gravity) interact with the resisting forces (strength of materials, reflected in lithology) to yield landforms. In particular, consider how they affect process (e.g., erosional or weathering processes), and how the resulting landforms might be affected by structure, tectonics, and time. I am asking you here to think about their inter-relations.

3. Consider the slope developed on the scarp of the McKinleyville Thrust (by the airport). What are the processes at work to form the slope, and on what time scales do they operate? (Hint: consider tectonics, erosional processes, weathering, types of deposits formed on the slope and at its base, lithology, etc.) If you were concerned with possible slides on the scarp, which variables would be dependent, which independent? What time scale(s) would you be looking at?

TECTONICS, EROSION RATES, STRUCTURAL AND LITHOLOGIC CONTROL OF LANDFORMS

1. Know the difference between *tectonic* and *structural* landforms.
2. Have a *general* idea (order of magnitude) of the *rates* associated with tectonic processes: plate movements, mountain building, uplift, subsidence.
3. Understand the general relationships between plate tectonics and rock associations/rock composition.
4. Have a *general* idea (order of magnitude) of the *rates* associated with denudation (erosion). What are high rates? low rates? What sorts of things are going to favor high rates of erosion? low rates? In general, how do rates of erosion compare with rates of tectonism?
5. How are erosion rates calculated? Be able to calculate an erosion rate given sediment discharge data.
6. Understand the idea behind *isostatic uplift* and *isostatic subsidence*. How do rates of isostatic adjustment compare with rates of tectonism?
7. How do rates of isostatic adjustment vary with time after loading or unloading of the crust? How can you compute the amount of uplift (or subsidence) to be expected given a specified amount of crustal unloading (or loading)? Be able to make such a calculation.
8. What implications does isostatic adjustment have for erosion of mountain ranges and creation of erosion surfaces?
9. Understand the relations between lava type/physical properties and resulting landforms. Be able to fit these into our plate-tectonic picture.

10. Understand the relations between geological structure (folds, faults, joints) and the resulting landforms--i.e., how do they control the shape of the land surface? How are they reflected in stream patterns? Be familiar with the relation of various types of structures (e.g., folds, thrust faults, strike-slip faults, normal faults, etc.) to plate tectonic environments.
11. How does lithology (rock type/characteristics) control landform development? Specifically, what sort of rock physical properties are important determinants of rock resistance and type of landforms developed? Be able to contrast typical landform development on: clays, sandstones, granites (or other massive plutonic rocks), and limestones.

WEATHERING AND SOIL FORMATION

1. Be aware of the major processes of mechanical weathering and chemical weathering. Think about what climatic, hydrologic, lithologic, and topographic conditions would favor/control each process.

*2. A gabbro is exposed in a) an arid area and b) a cool humid area such as the Sierra Nevada. Compare the sorts of weathering (both mechanical and chemical) you would expect in each of these areas, and describe the most probable weathering products. What weathering processes would be most important in each area and why? In which environment would the gabbro be most resistant, and why?

3. What are the important reactions in chemical weathering? Give an example of each, and state what climatic conditions you think would promote it. (Note-- this does not mean you have to write chemical equations, but that's fine if you want to.)

*4. Start with a granitic parent rock. What sorts of weathering would it undergo, what sort of weathering products might form, and what sort of soil might result under each of the following conditions: a) humid, hot; b) humid cool; c) dry cold; d) dry hot.

5. What climatic and physiographic/topographic factors affect the *rates* of mechanical and chemical weathering?
6. What are the important factors in soil formation, and how does each affect the resulting soil? Give examples.
7. Know the general *types* of clays formed by weathering (kaolinites, illites, vermiculites, montmorillonites, chlorites), the general ions in them, and the conditions under which each is most likely to form. (I don't care about you knowing the formulas or internal structure-- but you should know that illite is like a slightly leached muscovite, that kaolinite is just an aluminum silicate without a bunch of other cations, that montmorillonites typically contain Ca^{++} and can take water molecules into their structure, etc.)
8. What is special about montmorillonites and vermiculites that gives them particular geologic/geomorphic significance? (What can they do that other clays can't?)
9. Think about how soils can be used for geological purposes: e.g., for relative dating of deposits, for interpretation of past climates, etc. What soil properties might be most important in each case?
10. What is a paleosol? How might you distinguish it? What is saprolite? Colluvium? How could you distinguish the two?
11. Explain how soil forms: i.e., what processes go on to turn weathered rock into soil? What is a soil profile? How does it form? What are the chief *horizons*? How are they different? (Think about the the processes forming them and also about their different physical/chemical characteristics.)

PHYSICAL PROPERTIES OF GEOLOGICAL MATERIALS

1. What is meant by the *shear strength* of a material? What physical properties of a material comprise its strength? What is *cohesion* ? What factors affect strength due to *internal friction*?
2. What is *stress*? Distinguish between *normal stress* and *shear stress*. How is normal stress on a sloping surface calculated? shear stress? (Know the equations and the physical significance of each term.)
3. What is *pore pressure*? How does it affect the strength of a material? Explain why.
4. What is *strain*? Understand what a plot of stress vs. strain (e.g. fig. 4.26) tells you. What is *elastic* behavior? *viscous*? *plastic*?
5. Think about how the strength behavior of geologic materials might vary with time and give some implications for landscape evolution. How does the rheologic (stress-strain) behavior of geologic materials affect the resulting erosional processes/landforms?

SLOPES AND LANDSLIDES

1. What is the *factor of safety* of a slope? Physically explain its meaning. What does its numerical value tell you.
2. Describe the various types of landslides and suggest the important factors determining which kind will occur.
3. Show by a diagram the features you would use to recognize a landslide: 1) in the field; 2) on a photo; 3) on a map. Label the features appropriately.
4. What *forces* act on a slope to cause sliding? What are the driving forces? the resisting forces?
5. What factors act to reduce slope stability? How/why does each do so?
6. What are effective methods to stabilize slopes? How, in a physical sense (referring to the forces involved) does each one work?
7. What criteria could you devise to assess relative slope hazard? What things might you look for in the field, on maps or photos, or in the geological literature if you were asked to prepare maps showing relative landslide danger for a development, city, or county? Suggest how you'd go about it.
8. How can you recognize slides of varying ages, or assess the relative activity of slides?
9. Consider how the factors affecting stability of a slope are likely to change with *time* (both short-term and over geologic time.) Which factors will change most quickly? Why? How will stresses change with time? In what way might strength change? Why?